The Economic Benefits of Protecting Virginia's Streams, Lakes, and Wetlands

and

The Economic Benefits of Better Site Design in Virginia

December 2001

Prepared for:

DCR
Department of Conservation & Recreation
CONSERVING VIRGINIA'S NATURAL & RECREATIONAL RESOURCES

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Acknowledgements:

This project was funded in whole, or in part, by a grant from the Virginia Department of Environmental Quality, Virginia Coastal Program, through a Coastal Zone Management Program grant award (award # NA97OZ0181-01) from the National Oceanic and Atmospheric Administration.

Special thanks to Joe Battiata of DCR for Project Management and support, Rich Claytor, former CWP employee and project manager, Ed Ronsaville of Alleghany Inc. for work on the BMP database, and Karen Capiella and Chris Swann of CWP for their diligent efforts to complete the technical papers.

Technical Paper:

The Economic Benefits of Better Site Design in Virginia

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Many Virginia communities are currently struggling with the issue of balancing economic growth with protection of their natural resources and water quality. The rise in impervious cover associated with new development affects local water resources by reducing the infiltration of rainfall and increasing the volumes of stormwater runoff that eventually enter local waterbodies. One strategy for minimizing the effects of this additional runoff is through a variety of development strategies collectively known as "better site design".

Better site design is a process by which local governments review and modify their zoning codes and ordinances to permit new site development practices that preserve more pervious areas and lessen environmental impacts. These better site design practices allow communities to continue to realize the economic benefits of new development while improving their ability to protect the local environment . At the heart of the better site design process is a set of Model Development Principles that focus on the design of streets, parking lots, and site lots in new developments. Recently, 16 Model Development Principles were reviewed and endorsed by the Virginia Chesapeake Bay Local Assistance Department as conducive to addressing the general performance criteria of the Chesapeake Bay Preservation Act. Table 1 provides a summary of the sixteen principles applicable to the Chesapeake Bay Preservation Act.

The application of the better site design principles can help developers and local governments recognize increased economic benefits through reduced infrastructure requirements, decreased need for clearing and grading of sites, and less expenditure to meet stormwater management requirements due to reduced runoff volumes and nutrient export from a site. The following are examples of the economic benefits that Virginia communities can gain through the encouragement of better site design practices:

- For a 45 acre medium density residential site in Stafford County, Virginia, using better site design techniques would have saved $300,547 compared to a more conventional design due to reduced infrastructure and stormwater costs (CWP, 1998b).
- Studies have found that construction savings can be as much as 66% by using the open space designs encouraged by better site design (CWP, 1998a).
- Better site design can also reduce the need to clear and grade 35% to 60% of total site area. Since the total cost to clear, grade, and install erosion control practices can range up to $5,000 per acre, reduced clearing can be a significant cost savings to builders (Schueler, 1995).
- A summary of 40 years of fiscal impact studies showed that smart growth consumes 45% less land, costs 25% less for roads, 15% less for utilities 5% less for housing, and costs 2% less for other fiscal impacts than current trends of sprawl development. (Burchell and Listokin, 1995).

A 1990 study for the city of Virginia Beach compared the costs and benefits of conventional and smart growth development patterns. The study found that the smart growth pattern resulted in 45% more land preserved, 45% less in infrastructure costs to the city, and a 50% reduction in impervious surface due to roads (Siemon, Larsen and Purdy, et al., 1990).

Table 1. Virginia Model Development Principles

Conservation of Natural Areas

1. Conserve trees and other vegetation at each site by planting additional vegetation, clustering tree areas, and promoting the use of native plants. Wherever practical, manage community open space, street rights-of-way, parking lot islands, and other landscaped areas to promote natural vegetation.

2. Clearing and grading of forests and native vegetation at a site should be limited to the minimum amount needed to build lots, allow access, and provide fire protection. A fixed portion of any community open space should be managed as protected green space in a consolidated manner.

Lot Development

3. Promote open space development that incorporates smaller lot sizes to minimize total impervious area, reduce total construction costs, conserve natural areas, provide community recreational space, and promote watershed protection.

4. Relax side yard setbacks and allow narrower frontages to reduce total road length in the community and overall site imperviousness. Relax front setback requirements to minimize driveway lengths and reduce overall lot imperviousness.

5. Promote more flexible design standards for residential subdivision sidewalks. Where practical, consider locating sidewalks on only one side of the street and providing common walkways linking pedestrian areas.

6. Reduce overall lot imperviousness by promoting alternative driveway surfaces and shared driveways that connect two or more homes together.

Residential Streets and Parking Lots

7. Design residential streets for the minimum required pavement width needed to support travel lanes; on-street parking; and emergency, maintenance, and service vehicle access. These widths should be based on traffic volume.

8. Reduce the total length of residential streets by examining alternative street layouts to determine the best option for increasing the number of homes per unit length.

9. Residential street right-of-way widths should reflect the minimum required to accommodate the travel-way, the sidewalk, and vegetated open channels. Utilities and storm drains should be located within the pavement section of the right-of-way wherever feasible.

10. Minimize the number of residential street cul-de-sacs and incorporate landscaped areas to reduce their impervious cover. The radius of cul-de-sacs should be the minimum required to accommodate emergency and maintenance vehicles. Alternative turnarounds should be considered.

11. Where density, topography, soils, and slope permit, vegetated open channels should be used in the street right-of-way to convey and treat stormwater runoff.

12. The required parking ratio governing a particular land use or activity should be enforced as both a maximum and a minimum in order to curb excess parking space construction. Existing parking ratios should be reviewed for conformance taking into account local and national experience to see if lower ratios are warranted and feasible.

13. Parking codes should be revised to lower parking requirements where mass transit is available or enforceable shared parking arrangements are made.

14. Reduce the overall imperviousness associated with parking lots by providing compact car spaces, minimizing stall dimensions, incorporating efficient parking lanes, and using pervious materials in the spillover parking areas where possible.

15. Provide meaningful incentives to encourage structured and shared parking to make it more economically viable.

16. Wherever possible, provide stormwater treatment for parking lot runoff using bioretention areas, filter strips, and/or other practices that can be integrated into required landscaping areas and traffic islands.

To illustrate the economic advantages of better site design, a comparison of four development projects in Virginia that have applied a number of the Model Development Principles was recently conducted. Table 2 provides a short summary of the environmental cost benefits realized for the four projects reviewed. For a more complete description of each case study, consult the publication "Better Site Design: An Assessment of the Better Site Design Principles for Communities Implementing the Chesapeake Bay Preservation Act" available from the Center for Watershed Protection or from the Virginia Chesapeake Bay Local Assistance Department.

The assessment of Model Development Principle application in Virginia found that for the three residential case studies, the use of better site design could save up to 49% in total infrastructure costs compared to conventional development (CWP, 2000). Estimated total infrastructure costs include the costs of roads, gutters, sidewalks, landscaping, and stormwater management best management practices. In all three cases, the designs incorporating the Model Development Principles saved the developers more than $200,000 in infrastructure costs, while producing the same number of housing units. In addition, other more intangible economic benefits that may be derived from the use of better site design practices are not included in the case studies. These may include reduced heating and cooling costs for homeowners from tree preservation, decreases in flooding incidence and associated damage, and improved pollutant removal from the filtering action of forest and stream buffer areas. For a more detailed summary, consult "The Economic Benefits of Protecting Virginia's Streams, Lakes, and Wetlands" prepared for the Virginia Department of Conservation and Recreation by the Center for Watershed Protection.

Table 2. Benefits of Better Site Design vs. Conventional Development - 4 Virginia Studies

Case Study	Percent of Natural Areas Conserved	Percent Reduction in Impervious Cover	Percent Reduction in Stormwater Impacts			Percent Reduction in Total Infrastructure Costs
			Runoff	N Load	P Load	
Fields at Cold Harbor Hanover County	80.4	25.3	12.2	6.4	6.4	47.2
Governor's Land, James City County	49.3	21.7	14.3	17.5	17.3	14.5
Rivergate, Alexandria	0*	32	30	25	28	49
The Arboretum III, Chesterfield County	5.1	12	19.7	36	37.1	N/C

* - Open space area is maintained as landscaped parkland.
N/C - Not Calculated.

Conclusion

Better site design is an alternative to conventional development that focuses on preserving open space as natural areas and minimizing impervious cover in order to reduce the impacts of stormwater runoff on local streams. Studies have found that developments that permanently protect open space are often more desirable to live in, and consequently have higher property values (CWP, 1998a). Table 3 illustrates the cost savings for both local governments and developers associated with using better site design, most of which are related to infrastructure, maintenance, and stormwater costs.

As the case studies show, using better site design not only saves money, but provides significant reductions in nutrient export, especially at higher densities. Adoption of the Model Development Principles by Virginia communities will help protect local water quality while permitting the new development necessary for local governments to fund community services and protect watersheds.

Table 3. Burchell (1992-1997) Savings Due to Compact Growth Patterns

Area of Impact	Lexington, KY and Delaware Estuary	Michigan	South Carolina	New Jersey
Infrastructure Roads	14.8-19.7	12.4	12	26
Utilities	6.7-8.2	13.7	13	8
Developable Land Preservation	20.5-24.2	15.5	15	6
Agricultural Land Preservation	18-29	17.4	18	39

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October 2001

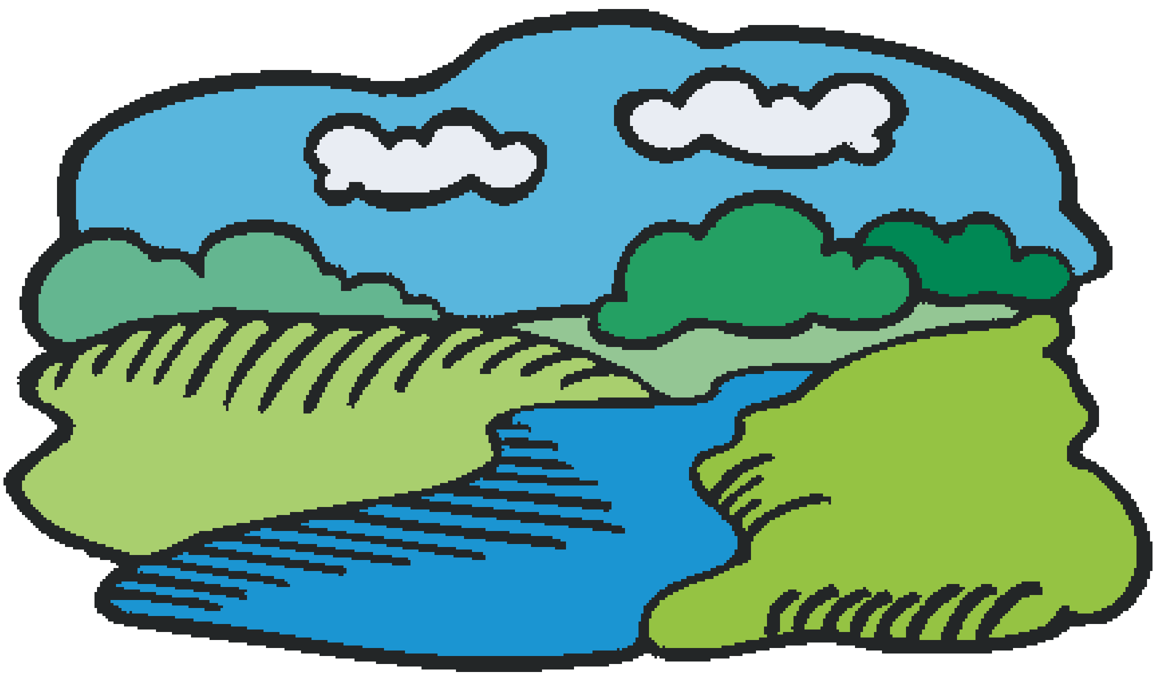

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Table of Contents

List of Figures

List of Tables

1.0 Introduction

In 1989, the economic importance of the Chesapeake Bay was estimated to be $678 billion per year to the economies of Virginia and Maryland through commercial fishing, marine trade, tourism, port activities, and land values (MDEED, 1989). While it is often difficult to calculate the "true" value of a waterbody or watershed, the above statistic shows that society often measures the value of these resources in terms of factors such as income from water-related activities, property values, and construction costs.

The irony of placing an economic value on water and other natural resources is that, for the most part, the services of these resources are freely available to those who wish to use it. However, human activity that has a negative impact on water resources such as dumping of toxic waste into rivers and streams, or sediment pollution downstream due to extensive land clearing upstream, also has a negative economic impact on the value of these water resources to others who wish to use them. In this case, the person creating the negative impact is transferring the cost of carrying out these activities responsibly to the general public, who will end up paying the consequences. To illustrate this externality, EPA estimated that because of urban runoff pollution, hundreds of millions of dollars are lost each year through added government expenditures, illness, or loss of economic output (USEPA, 1998). The intent of this report is to document these economic costs related to poor environmental regulation or lack thereof, as well as to document the economic benefits of implementing environmental regulations.

The Center for Watershed Protection has conducted a literature search and synthesis of potential economic benefits associated with environmental protection regulations such as stream buffer establishment, wetland protection, erosion and sediment control, floodplain protection, zoning restrictions, stormwater management (quantity and quality), forest conservation, and source water protection. This study identifies sources that illustrate land value and other benefits associated with environmental protection programs as well as possible negative economic consequences of ineffective or non-existent programs. This research is provided in support of Virginia's coastal nonpoint source stormwater management program. Therefore, sources that reference Virginia economic considerations were given preference over others. A list of references is included with this report.

2.0 Economic Benefits of Watershed Protection

The Center for Watershed Protection previously developed an approach to watershed protection that applies eight tools to protect or restore aquatic resources. These eight tools of watershed protection are: watershed planning, land conservation, aquatic buffers, better site design, erosion and sediment control, stormwater treatment practices, non-stormwater discharges, and watershed stewardship programs (see Figure 1). This report reviews the economic benefits of environmental regulations within the framework of these eight tools.

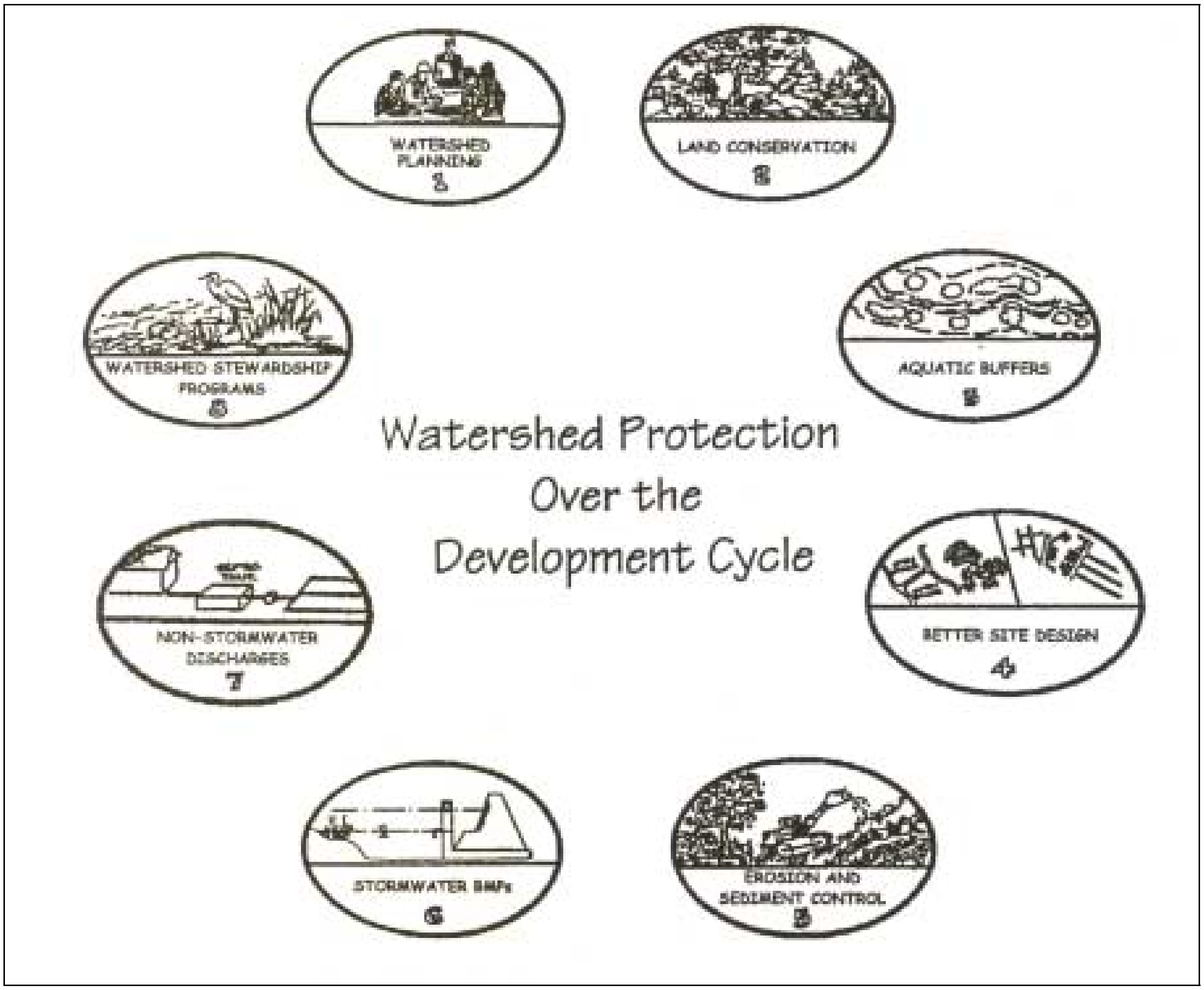


Figure 1 - The Eight Tools of Watershed Protection

The eight tools correspond roughly to the stages of the development cycle from land use planning, site design, construction and ownership. Communities can apply these tools to guide where and how new development occurs, and to design development to have the smallest possible impact on streams, lakes, wetlands and estuaries. While economic research on some of the tools is rather sparse, much of the evidence indicates that these tools can have a positive or at least neutral economic effect, when applied properly. Each tool is described in more detail in this report.

There are two types of economic benefits of implementing environmental protection regulations: income generated by economic activities which rely on water or other natural resources, and a reduction in or avoidance of costs which may result from environmental degradation and consumption of natural resources. These benefits are listed in Table 1 by the eight watershed protection tools. Environmental regulations that correspond to the watershed protection tools are listed next to each tool.

Table 1 – The Economic Benefits of Watershed Protection

Watershed Protection Tool	Economic Benefit
Watershed Planning – zoning tools, urban growth boundaries, source water protection	• Income from fisheries, agriculture, industry, and recreation and tourism • Reduction of drinking water treatment costs, health care costs, and restoration costs
Land Conservation – forest conservation, wetland protection, preservation of parks and open space	• Income from recreation and tourism and increased property values • Reduction of energy costs, health care costs, flood control and stormwater quality and quantity treatment costs
Aquatic Buffers – resource protection areas, stream buffers	• Income from fishing and increased property values • Reduction of flood control and stormwater quality and quantity treatment costs, and restoration costs
Better Site Design – cluster development, impervious cover limits	• Income from increased property values • Reduction of construction, maintenance, and infrastructure costs, as well as stormwater and flood control costs
Erosion and Sediment Control – channel protection, clearing and grading, construction site erosion and sediment control	• Income from marine and port activities and increased property values • Reduction of drinking water treatment costs, construction costs, restoration costs, and dredging costs
Stormwater Treatment Practices **– stormwater regulations, floodplain protection**	• Income from increased property values • Reduction of flood damage costs, reduction of cost of structural stormwater and flood controls
Non-Stormwater Discharges – ***point source controls, septic system regulations***	• Reduction of pollution-related health costs and restoration costs
Watershed Stewardship Programs – ***watershed education and management, monitoring, and residential, industrial and commercial pollution prevention programs***	• Income from stewardship programs • Reduction of restoration costs

The benefits listed above may be direct benefits, indirect benefits, or diversionary benefits. Direct benefits of water quality improvement include enhanced recreational water activities and reduced exposure to contaminants (USEPA, 1999). Indirect benefits include enhancement of near-stream recreational activities, or the quality of residing, working, or traveling near water (USEPA, 1999). Diversionary benefits include avoided water storage replacement costs and water treatment costs (USEPA, 1999). The remainder of this report provides a more comprehensive review of each of the above benefits and cost reductions associated with environmental regulations within the framework of the eight tools of watershed protection.

2.1 Watershed Planning

Watershed planning is perhaps the most important watershed protection tool because it involves decisions on the amount and location of development and impervious cover, and choices about appropriate land use management techniques. Land use planning techniques include overlay zoning, urban growth boundaries, down zoning, transfer of development rights, and many others. The benefit of these tools is improved water quality due to a reduced pollutant load; however, there are often costs associated with many of these land use planning techniques, such as reduced tax revenue and less economic activity. Down zoning in particular can be costly to developers, landowners, and the community because a reduction in density deprives landowners of the potential value of development. Transfer of development rights may help to offset these costs by transferring development potential from sensitive watershed areas to areas designated for growth without taking away the benefits of potential development value. The benefits of watershed planning are difficult to quantify, but are usually measured in terms of the economic benefits of improved water quality.

Stream quality is directly related to land use and consequently impervious cover. Because many land use planning elements also fall under at least one of the other watershed protection tools, this section will focus on the economic benefits of watershed planning regulations that specifically protect water quality. Good water quality has important economic benefits because it is essential for productive fisheries and water-related recreation. Improvements in water quality can also reduce drinking water treatment costs, dredging costs, pollution-related medical costs (e.g., water-bourne illness), and stream and lake restoration costs.

The U.S. economy also depends on clean water. Water used for irrigating crops and raising livestock helps American farmers produce and sell $197 billion worth of food and fiber (USEPA, 2000c). Water is equally important to industry. Manufacturers use about nine trillion gallons of fresh water every year (USEPA, 2000c). The soft drink manufacturing industry alone uses more than 12 billion gallons of water annually to produce products valued at almost $58 billion (USEPA, 2000c).

The fisheries industry is important in the U.S., and especially in the Chesapeake Bay region. The total economic value of commercial fishing in the Chesapeake Bay was estimated to be $520 million per year in 1987 dollars (MDEED, 1989). In 1999, 460 million lbs of fish valued at $108 million were landed in Virginia (NMFS, 2001). Particularly important in Virginia are oysters and blue crabs. In 1999, blue crabs brought in $21 million while the eastern oyster generated $967,000 (NMFS, 2001).

This income from fisheries can quickly decline when water quality declines. Pollutants can contaminate or suffocate fish, as well as degrade fish habitat. The EPA estimated that stormwater runoff costs the commercial fish and shellfish industries approximately $17 million to $31 million per year (USEPA, 1999). Nitrogen and phosphorus are often associated with stormwater runoff, and high levels of these nutrients have been linked to fish kills caused by the toxic dinoflagellete *pfiesteria piscicda*. According to Douglas W. Lipton, coordinator of the Maryland Sea Grant Extension Program, *pfiesteria* cost the Chesapeake Bay seafood industry $43 million in 1997, and the recreational fishing industry $4.3 million.

Water quality is just as important for recreational fishing and other water-related recreational activities such as rafting, swimming, and boating. The average estimated value of freshwater for recreational fishing and wildlife habitat in the U.S. was $48 per acre foot (Frederick, et al.*, 1996), while freshwater wetlands were valued at $200 per acre for recreational use (Thibodeau and Ostro, 1981). The following statistics illustrate the contribution of recreational fishing and water-related recreation to the economy.*

- A third of all Americans visit coastal areas each year, making a total of 901 million trips while spending about $44 billion (USEPA, 2000c).

- In 1996, total expenditures related to recreational salt and freshwater fishing in Virginia were $821,318 (USFWS, 1997).

- On North Carolina's Nantahala River, raft trip participants increased 700% between 1972 and 1981, and generated $1.8 million in expenditures in 1982 (Swain County Board of Commissioners, 1982).

- *A national survey determined that people were willing to pay more for a higher quality outdoor recreation opportunity (Walsh,* et al.*, 1986).*

Medical costs associated with the treatment of illnesses related to water pollution may be reduced when water quality is improved. Pollution-related illness commonly occurs from direct contact with polluted water or from eating contaminated fish or seafood. The USEPA (1994) estimated the economic benefits of the Clean Water Act related to human health effects to be $40 million to $320 million in 1993 dollars. Pollution-related illness can also occur from drinking contaminated water. Currently, EPA estimates that at least half a million cases of illness annually can be attributed to microbial contamination in drinking water (USEPA, 2000c).

The costs associated with source water protection are relatively small when compared to the costs of installing a drinking water treatment plant, locating new drinking water sources, constructing new systems, and cleaning up contamination sites. Other potential costs that go along with cleaning up after a contamination incident include decreased property values, loss of tax base, loss of citizens confidence in their drinking water, public utilities, and community leaders (USEPA, 2001).

Examples of capital costs for drinking water treatment plants are $660 million for the Croton reservoir in New York and $150 million for Portland-Bull Run (cost information was obtained from the respective treatment plants). Operation and maintenance costs for these reservoirs are $11 million and $4 million per year, respectively. These reservoirs are currently unfiltered, therefore treatment costs are lower than for filtered water supplies. The estimated cost of the proposed filtration of New York City's Catskill/Delaware water supply is $4.57 billion (Aponte Clarke and Stoner, 2001).

On average, protecting water quality is less costly than restoring or treating water after it has been polluted. The average annual federal cost of reducing nonpoint source inputs of nitrogen, phosphorus, and sediment to Highland Silver Lake in southwest Illinois was estimated to be $3,000 to $9,000 per percentage point reduction in pollutant loading for non-structural practices. Compare this to the cost for structural treatment practices such as impoundments, which can be greater than $59,000 per percentage point (Setia and Magelby, 1988). Lake restoration costs can be even greater than the water quality protection practices, and will vary depending on the technique used as well as the characteristics of the lake. For example, alum addition can cost $14,000 per 100 tons, shading and sediment covers can range from $1,375 to $65,475 per acre, and plant harvesting costs on average $140 to $310 per acre (USEPA, 1990). Often, more than one technique is used to restore a body of water, which may raise these costs significantly.

2.2 Land Conservation

The second tool, land conservation, involves choices about the types of land that should be conserved to protect a watershed. Conserving forests and open space, and protecting sensitive areas such as wetlands can be accomplished through techniques such as land acquisition and conservation easements, and has an important economic value. While land conservation regulations may have associated costs related to the loss of marketable land, the benefits can greatly outweigh these costs. The conservation of trees has value for keeping energy costs down and reducing air pollution, while wetland protection can reduce flood damage and stormwater management costs. Forest and open space that is preserved as park or greenbelt can also be used for multiple types of recreation.

Properties located near these natural areas have higher real estate values, may appreciate at a faster rate, or have higher than normal resident retention rates. Studies show that people are often willing to pay more to live or work near parks or open space, and lots with trees or near a park tend to sell at a faster rate than typical lots. On average, property values have been found to increase by 5 to 33% when located near a park or greenbelt. The following studies document these findings.

- *The results of a Maryland survey show almost half the respondents said they would be inclined to move if existing open space in their community were lost (CBP, 1998).*

- *According to a Bank of America survey, real estate agents say that homes with treed lots are 20% more saleable (CBP, 1998).*

- *A land developer donated a 50 foot wide, seven mile easement to provide a critical link for the Big Blue Trail in Front Royal, Virginia. The trail ran along the perimeter of a subdivision, and the developer advertised that the trail would cross 50 parcels, all of which sold within four months (American Hiking Society, 1990).*

- *1294-acre Pennypack Park in Philadelphia was found to account for 33% of the land value of properties located 40 feet from the park, compared to 9% of properties located 1000 feet away (CBF, 1996b; Hammer,* et al.*, 1974).*

- *In Boulder, Colorado, the average value of property adjacent to a greenbelt was 32% greater than properties 3200 feet away (Correll,* et al.*, 1978).*

- *In Salem, Oregon, urban land adjacent to a greenbelt was worth $1200 more per acre than urban land 1000 feet away (Nelson, 1986).*

- *An analysis of property surrounding four parks in Worcester, Massachusetts found that homes located 20 feet away sold for $2,675 more than similar homes located 2000 feet away from the park. This study also found that if residents were willing to pay $1 per visit to the park, the annual income of $425,000 would be greater than the annual cost to maintain the park of $125,000 (More,* et al.*, 1982).*

- *In the Whetstone Park area of Columbus, Ohio, a nearby park and river accounted for 7.5% of the selling prices of residential homes (Kimmel, 1985).*

- *Two regional economic surveys document that conserving forests on residential and commercial sites can enhance property values by an average of 6 to 15% and increases the rate at which units are sold or leased (Morales, 1980; Weyerhaeuser, 1989).*

Because many of these conservation areas are preserved as parks, there may be a significant amount of income generated through recreation activities such as biking, hiking, wildlife-viewing, and hunting. The following statistics illustrate the contribution of these activities to local economies.

- *The economic value of tourist activities in the Chesapeake Bay region was estimated to be $8.4 billion per year in 1987 dollars (MDEED, 1989).*

- *In 1996, total expenditures related to wildlife-watching in Virginia were $698,245 (USFWS, 1997).*

- *In 1996, total expenditures related to hunting in Virginia were $518,891 (USFWS, 1997).*

- *A survey by the U.S. Fish and Wildlife Service found that 60% of suburban residents actively engage in wildlife watching, and are willing to pay premiums for locations in settings that attract wildlife (USFWS, 1993).*

- *A national survey determined that people were willing to pay more for higher quality outdoor recreation opportunities (Walsh,* et al.*, 1986).*

Recreation activities involving exercise can also reduce health care costs. People who exercise regularly have 14 percent lower claims against their medical insurance, spend 30 percent fewer days in the hospital, and have 41 percent fewer claims greater than $5,000. These figures were taken from a Corporate Wellness Study for the city of San Jose, Department of Recreation in 1988 (cited in NPS, 1995). The creation of greenways and trails also reduces employees commuting costs because they provide the opportunity to commute by foot or bicycle (NPS, 1995). People are also more likely to exercise if they have convenient access to a park or greenway with trails or other type of recreation area.

Another type of cost savings that can result from tree conservation and forest preservation is reduced home heating and cooling costs. Energy savings of 10% can result by adding as little as 10% tree cover to buffers near buildings (CBP, 1998). This is because a single mature tree releases about 100 gallons of clean water per day into the atmosphere, and provides the cooling equivalent of nine room air conditioners operating at 8000 btus per hour for twelve hours a day (CBP, 1998). Studies by the American Forest Association have shown that homes and businesses that retain trees save 20% to 25% in their energy bills for heating and cooling. In some cases, trees can reduce winter heating costs by up to 40% (Newsweek, 1979).

Wetland and forest preservation is important not only to protect the diversity of wildlife and habitat there, but also because of the capacity of wetlands and forests to hold floodwaters and filter sediment and nutrients, as well as other toxicants. The cost of preserving or protecting a wetland is therefore less than the benefits gained when taking into account the cost of floodwater storage and water treatment that would otherwise be necessary if the wetland were lost. Forested areas also store floodwaters and filter sediment and nutrients, because the vegetation slows down runoff and promotes infiltration. The following studies document the economic value of wetlands and forest for flood control and water treatment.

- *The Minnesota DNR computed the average cost to replace an acre-foot of floodwater storage to be $300. Therefore, if development eliminates 1 acre of wetland that naturally stores 1 foot of water during a storm, the public replacement cost is $300. The cost to replace 5000 acres of wetlands lost annually in Minnesota would be $1.5 million (FMA, 1994)*

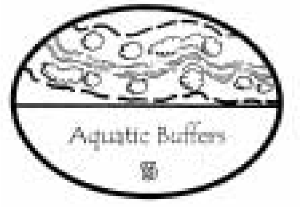
- The wetlands of Congaree Bottom Swamp in South Carolina provide sediment, toxicant, and excess nutrient removal. The least cost substitute for comparable water quality services provided would be a $5 million water treatment plant (FMA, 1994).

- American Forests found that from 1972 to 1996, areas with high vegetation and tree canopy coverage declined by 37% in the Puget Sound area. It is estimated that replacing this lost stormwater retention capacity with reservoirs and other engineering structures would cost $2.4 billion or $2 per cubic foot (American Forests, 1998).

- In Atlanta, Georgia, it was found that a 20% loss in trees and other vegetation in the metropolitan region provided a 4.4 billion cubic foot increase in stormwater runoff; officials estimated that at least $2 billion would be required to build containment facilities capable of storing the excess water (American Forests, as cited in US Water News, 1997).

- The estimated value of freshwater wetlands for water treatment plant function is $10,578 per acre (Thibodeau and Ostro, 1981).

2.3 Aquatic Buffers



The third watershed protection tool, aquatic buffers, involves choices on how to maintain the integrity of streams, shorelines and wetlands, and provide protection from disturbance. Stream and shoreline buffers perform a variety of functions that promote infiltration, slow runoff, store floodwaters, stabilize stream banks, provide stream surface shading, provide habitat, and filter nutrients and sediment. Unfortunately, many development projects will clear right up to the stream edge and remove protective streamside vegetation. Buffer programs preserve existing buffers and create new ones along a stream at a designated distance from the stream edge. Economic benefits resulting from establishing aquatic buffers include: increased property values, reduced flood damage and restoration costs, improved fisheries, and reduced drinking water treatment costs. The following studies document these economic benefits by category.

Property Values

- The Maryland Conservation Act encourages conservation of trees and buffers. Developers in Maryland say they are receiving 10 to 15% premiums for lots adjacent to forest and buffers (CBP, 1998).

- In one Maine case study, increased water clarity (increased visibility depth of 3 feet) due to the addition of lake buffers increased property values by $11 to $200 more per foot of shoreline property (Michael, *et al*., 1996).

- An economic study in California showed that home prices increased on average 17% because of trees and buffers (CBP, 1998).

- Homes near seven California stream restoration projects had 3 to 13% higher property values than homes on unrestored streams. Most of the perceived value was due to enhanced buffers, habitat, and recreation afforded by the restoration (Streiner and Loomis, 1996).

- Fawn Lake, a 200 acre golf course/lake community in Spotsylvania County, Virgina, received premiums of at least $10,000 per lot for property adjacent to buffer zones or open space compared to interior lots. The total preservation area of the development was 464 acres in buffer zones and open space and these areas were successfully incorporated into the marketing strategy (Melton, 1997).

Fish Habitat

- Land clearing for development can reduce stream surface shading. Studies have shown that when stream surface shade is reduced to 35%, trout populations can drop by as much as 85% (CBP, 1998; Galli, 1991). Stream and shoreline buffers also contribute to better water quality, which means better fish habitat and therefore more productive fisheries.

Flooding

- *Retaining forest area and buffers has reduced stormwater costs in Fairfax County, VA by $57 million (CBP, 1998).*

- Observations of flood damage after major flooding in Virginia in 1994-95 showed that where forest and trees were retained in the floodplain or along streams, the damage was less extensive than in grassy or farmed areas (CBP, 1998).

Water Quality

- Riparian forest buffers remove an estimated 21 lbs of nitrogen per acre per year for \$0.30 per pound, compared to \$3 to \$5 per pound for Washington, D.C. area wastewater treatment facilities (CBP, 1998).

Stream Restoration

- *In Fairfax County, Virginia, a local bond issue provided nearly \$1.5 million to restore two miles of degraded stream and riparian area (CBP, 1998). Retaining stream buffers is a much more cost-effective way to preserve the integrity of the stream and protect it from erosion and habitat degradation.*

- A summary of 15 stream restoration projects in Maryland and Illinois ranging from 500 feet to 13,200 feet in length showed costs ranging from \$12,000 to \$2.2 million per project (CWP, 2000b).

- Streambank restoration projects can cost up to \$100,000 per linear foot for concrete channelization, compared to \$100 per linear foot for vegetative methods such as reforesting the buffer area (Firehock and Doherty, 1995).

2.4 Better Site Design

Better site design is an alternative to conventional sprawl-like development that focuses on clustering development in order to preserve open space, treating stormwater for quantity and quality, and minimizing impervious cover in order to reduce impacts to local streams. Cluster developments, particularly those that permanently protect open space, are often more desirable to live in, and consequently have higher property values. Additionally, there are various cost savings associated with environmentally sensitive development, most of which are related to infrastructure, maintenance, and stormwater costs.

The proximity to a forested area, park or open space often increases property values and real estate premiums; therefore, it is to a developers' advantage to conserve trees and open space within a subdivision. Cluster developments, which use better site design techniques such as tree conservation, reduction of impervious cover, increased common open space, and minimal clearing and grading, typically keep 40 to 80% of a site in permanent community open space and yield lots that bring a higher selling price. In addition, urban forests boost property values by reducing irritating noise levels and screening adjacent land uses. These costs savings are documented with the following examples.

- Clustered homes with permanently protected open space in a development in Amherst, Massachusetts appreciated at an average annual rate of 22% compared with 19.5% for a conventional subdivision. This translated into an average difference in selling price of $17,100 in 1989, even though the conventional subdivision had larger lot sizes (Lacy, 1991).

- In Howard County, MD a cluster development with an average lot size of one acre had the same market value as a conventional subdivision with one to five acre lots (Legg Mason, 1990).

- *The Maryland Critical Areas Act and the New Jersey Pinelands land use regulations improved the tax base because the value of developed land increased by 5% to 17%, and the value of vacant land increased by 5% to 25% (Beaton, 1988; Beaton, 1991). Similar land use restrictions designed to protect the Chesapeake Bay increased property values by 14% to 27% (Fausold and Lillieholm, 1996).*

- *It was projected in 1970 that for a 760 square mile area in Maryland, uncontrolled development would yield $33.5 million in land sales and development profits by 1980. Open space development would yield $40.5 million, yielding $2300 more per acre (Caputo, 1979).*

What many developers do not realize is that using better site techniques can actually cost less than conventional design. However, in cases where the use of better site design techniques creates additional construction costs, these costs are usually offset by increased revenues and higher than normal resident retention rates (CBP, 1998). The following studies document the decrease in infrastructure and maintenance costs associated with better site design.

- *For a medium density residential site in Stafford County, Virginia, using better site design techniques saved $300,547 compared to a conventional design due to reduced infrastructure and stormwater costs (CWP, 1998).*

- *An assessment of better site design techniques in Virginia found that for three residential case studies, better site design cost from 14.5 to 49% less than conventional development, due to reduced infrastructure costs (CWP, 2000).*

- *A Prince William County, Virginia report in 1998 estimated that each new sprawl-designed home costs that locality $1600 more than is returned in taxes and other revenues (CBF, 2000).*

- *Suffolk, Virginia estimates that each new single-family home costs the increasingly spread-out city $7000 in capital for infrastructure and services (CBF, 2000).*

- *A 1986 American Farmland Trust study determined that school transportation costs for a 1,000 unit development at 1 dwelling unit per acre in Virginia's Loudon County would be over 5.5 times greater than the same number of units at 4.5 dwelling units per acre (American Farmland Trust, 1986).*

- *Case studies of developments in New York, Iowa, and North Carolina showed that corporate land owners can save $270 to $640 per acre in annual mowing and maintenance costs when open lands are managed as a natural buffer area rather than turf (WHEC, 1992).*

- *The 1988 public costs for maintaining open space in Boulder, Colorado were $2425 to $3125 less than maintaining developed land (Crain, 1988).*

- *Tax revenue spent on county services in Culpeper County, Virginia in 1987 was 6.6 times greater for residential land uses than for industrial, commercial, farm, forest, or open lands. The same study showed that the average new residential unit in Culpeper County can be expected to produce a deficit* *in the county budget of $1242 (1988 dollars) because the public service costs exceed the revenue (Vance and Larson, 1988).*

- *A study by the Chesapeake Bay Foundation (1996a) derived cost estimates for two development scenarios for Remlick Farm Hall that result in equivalent yield to the developer. In the conventional scenario, the farm is subdivided into 84 large-lot units, whereas in the open space scenario, 52 higher-end units are located on smaller lots in three clusters. Over 85% of the site is retained in open space, as farmland, forest or wetland. The authors compute net development savings of over $600,000 for this 490-acre cluster development (50% lower than the conventional scenario). Most of the savings are attributed to lower infrastructure costs (CBF, 1996a).*

- *Cluster development can reduce the capital cost of subdivision development by 10 to 33%, primarily by reducing the length of the infrastructure needed to serve the development (NAHB, 1986; Maryland Office of Planning, 1989; Schueler, 1995).*

- *Better site design can also reduce the need to clear and grade 35% to 60% of total site area. Since the total cost to clear, grade, and install erosion control practices can range up to $5,000 per acre, reduced clearing can be a significant cost savings to builders (Schueler, 1995).*

Much of the reduction in capital costs can be attributed to a reduction in impervious cover. According to Schueler (1997), potential savings related to impervious cover reduction include:

- *$150 for each linear foot of road that is shortened*

- *$25 to $50 for each linear foot of roadway that is narrowed*

- *$10 for each linear foot of sidewalk that is eliminated*

- *$1,100 of construction cost per space that is eliminated in a commercial parking lot, with a lifetime savings in the range of $5,000 to $7,000 per space when future parking lot maintenance is considered*

Better site design can reduce site impervious cover from 10% to 50% (depending on the original lot size and layout), thereby also lowering the cost for both stormwater conveyance and treatment (Schueler, 1997). This cost savings can be considerable, as the cost to treat the quality and quantity of stormwater from a single impervious acre can range from $30,000 to $50,000 (CWP, 1997). Additionally, the use of non-structural methods of stormwater conveyance and treatment such as grass channels, swales, bioretention areas, and site grading, is typically less expensive than conventional stormwater techniques. Some examples are cited below:

- *Liptan and Brown (1996) documented two commercial/industrial case studies in Oregon where the use of bioretention and swales reduced the size and cost of conventional storm drains for stormwater requirements. Total savings per project ranged from $10,000 to $78,000 (Liptan and Brown, 1996).*

- *In the same study, Liptan and Brown (1996) found that the use of open space design techniques at a residential develoment in Davis, California provided an estimated infrastructure construction cost savings of $800 per home (Liptan and Davis, 1996).*

- *The Oregon Museum of Science and Industry in Portland saved $78,000 by using vegetated swales instead of conventional stormwater management to convey and treat runoff (Lehner,* et al.*, 1999).*

- *Developers of Prairie Crossing in Grayslake, Illinois saved $2.7 million by using swales, prairie, and wetlands for stormwater conveyance and treatment, and eliminating curb and gutter (Lehner,* et al.*, 1999).*

- *Curb and gutter costs $40 to $50 per running foot, which is 2-3 times more than an engineered swale (SMBIA, 1990; CWP, 1998).*

2.5 Erosion and Sediment Control

Erosion and sediment control deals primarily with the clearing and grading stage in the development cycle when runoff can carry high quantities of sediment into nearby waterways. Sediment is the most common pollutant affecting U.S. waters (USEPA, 2000b). Sediment pollution and deposition impacts navigable waterways and raises drinking water treatment costs, while shoreline and bank erosion can erode property and destroy fish habitat. Therefore, the control of erosion at its source through construction site erosion and sediment controls, channel protection, and clearing and grading restrictions can increase property values, as well as reduce drinking water treatment costs, stream and lake restoration costs, and dredging costs.

A 1998 analysis of the Phase II Stormwater Rule showed that the annual estimated gross federal benefits for construction site erosion and sediment controls as well as post-construction controls were comparable to the costs of these erosion and sediment controls (USEPA, 1999). However, the benefits to the developer may be even greater. For example, reducing the amount of clearing and grading on a site can save money (as well as trees) in the long run, since the cost to clear, grade, and install erosion control devices can range up to $5,000 per acre (DEDNREC, 1997).

Water resources are essential to the operation of the marine industry. Erosion and sediment control may ultimately decrease the amount of dredging needed to keep these waterways cleared for boat traffic. It costs $10 to $11.5 million annually to dredge and dispose sediments deposited into Baltimore Harbor to keep it navigable (CBP, 1998). Listed below are some facts documenting the economic benefits of marine and port activities on local economies:

- The economic impact of port activity in the Chesapeake Bay (from 3 major ports, Baltimore, Norfolk, and Newport News) was estimated to be $5.3 billion per year in 1987 (MDEED, 1989).

- The economic impact of the shipbuilding and repair industry in the Chesapeake Bay region was estimated to be $17.3 billion per year in 1987 dollars (MDEED, 1989).

- Frederick, *et al*. (1996) estimated the average value of freshwater for navigation to be $146 per acre foot for the entire U.S.

Dredging is necessary not only in navigable waterways, but also in drinking water reservoirs that lose capacity with excess sediment deposition. Because a major function of drinking water treatment plants is to remove sediment, it stands to reason that the more sediment in the intake water, the more effort will have to be expended to remove the sediment and ultimately dispose of it. Therefore erosion and sediment control regulations can prevent an increase in drinking water treatment costs.

To illustrate the costs of sediment pollution, the following example computes the sediment loading to a downstream reservoir during one year from active construction on a 100 acre mixed use site. The Simple Method (Schueler, 1987) was used to calculate the sediment load in pounds per year from the construction site, assuming 40 inches of annual rainfall, 0.9 effective precipitation value, a runoff coefficient of 0.5 for the construction site, and an event mean concentration (EMC) of 15,000 mg/L (taken from Owens, *et al*., 2000). Using 100 pounds per cubic foot as the dry density of the sediment, the volume of sediment entering the reservoir during one year was determined to be 2,267 cubic yards. Assuming a cost of $20 per cubic yard for dredging, transport, and disposal of the material, the annual cost would be $45,340 to remove the sediment generated from one source alone. When other sources of sediment to the reservoir are accounted for, this cost will rise significantly.

Shoreline and bank erosion eats away at property values as well as the shoreline. The economic benefits of erosion and sediment control are illustrated with the following studies.

- A study in the Lake Erie, Ohio area used the hedonic price method[1] to predict that an erosion control device lasting 8 years would raise property values by $5,500, and one lasting 20 years would raise property values $11,000 (Kreisel, *et al*., 1993).

- Using hedonic price indices, Van deVerg and Lent determined that property values for Chesapeake Bay shoreline homes in Maryland would decline on average $3,474 per annual foot of erosion (Van deVerg and Lent, 1994).

2.6 Stormwater Treatment Practices

The sixth tool, stormwater treatment practices, involves choices about how, when, and where to provide stormwater management within a watershed, and which combination of management practices can best meet watershed objectives. Stormwater regulations that are designed to prevent flooding or reduce damages from flooding have measurable economic benefits. Not only are the costs of flood damage reduced or in some cases eliminated, but non-structural controls such as floodplain protection also reduce the need for structural stormwater controls of these larger storms. Effective stormwater management that reduces flood risk may also increase the property values of nearby homes. Stormwater treatment practices also improve water quality, and these benefits are discussed under the first watershed protection tool, watershed planning.

[1] The hedonic price index is a statistical method for determining the prices of the individual attributes of properties.

Flood damages can be extensive, particularly in areas where there are no regulations regarding development in the floodplain. From 1990-1999, flooding was the most frequently reported disaster in the U.S., and according to FEMA more than $7.3 billion was committed by FEMA for flood damages (FEMA, 2001). Conversely, FEMA placed a value of $800 million on the amount communities are collectively saving on an annual basis through the National Flood Insurance Program by adopting and enforcing responsible floodplain management and regulating new development in flood hazard areas (FEMA, 1999). The following studies document the economic impacts of flooding and flood control.

- *The so-called 'Grandfather' of water resources management, Gilbert White estimated in 1958 that for every six dollars in potential damages reduced each year by new flood protection measures, at least five dollars in additional damage resulted from development in floodplains. Flooding accounts for larger annual property losses than any other single geophysical hazard (Riley, 1985).*

- *At a cost of $27 million, Baltimore County acquired 100 homes and cleared the 100 year floodplain in eight of its most critical watersheds, saving $85 million in local storm damage assistance costs over 5 years (Caputo, 1979).*

- *A national study of ten programs that diverted development away from flood-prone areas found that land next to protected floodplains increased in value by an average of $10,427 per acre (Burby, 1988).*

The total gross benefits of the Phase II Stormwater Rule were estimated to be between $671.5 million and $1.10 billion per year, compared to total annual costs of $847.6 million to 981.3 million (USEPA, 1999). The benefits included reduced damages from flooding, as well as increased property values. Property values can increase from reduced flood risk as well as residents desire to live near water features such as stormwater ponds. The following studies document residents' preference to live near urban runoff controls as well as the real estate premiums paid for this privilege.

- *A survey of 143 residents in Champaign-Urbana, Illinois found 82.3% of residents were willing to pay a premium to be located next to a wet pond. Overall, the respondents believed lots adjacent to wet ponds were worth on average 21.9% more than non-adjacent lots in the same subdivision (Emmerling-DiNovo, 1995).*

- *In 1982 the National Institute for Urban Wildlife surveyed 600 homeowners in Columbia, Maryland. 75% of homeowners expressed a preference for lots near wet basins, and felt the pond presence increased property values. 73% of respondents were willing to pay more to live in an area with a detention basin designed to enhance fish and wildlife use. The same survey found that developments with wet ponds have higher initial costs, but these costs are recovered by a faster sales rate (Adams,* et al.*, 1986).*

- *An EPA study of several developments in Virginia showed that real estate premiums for property fronting urban runoff controls averaged up to $7,500 per unit for condominiums, up to $10,000 per unit for townhomes, up to $49,000 per unit for single family homes, up to $10 per month per apartment rental, and up to $1 per square foot for commercial rentals (USEPA, 1995).*

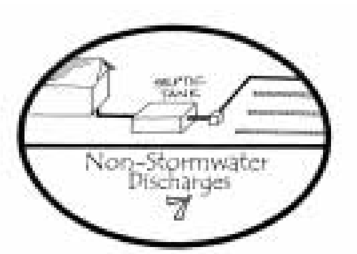
- *Chancery on the Lake, a condominium development in Alexandria, Virginia is a residential project with an attractive 14-acre urban runoff detention area. The wet pond is the focal point of the*

- *development, and is surrounded by a walking trail and will be used for fishing. Condominiums that front the lake are selling at a $7,500 premium (Harden, 1995).*

- *In Fairfax County, Virginia, the townhouse community of Pinewood Lakes has been selling waterfront townhomes at a premium for 23 years. The average sales price of a waterfront townhome is $6,117 more than a similar home without a view of the constructed pond (Wade, 1995).*

- *A townhouse community in Tysons Corner, Virginia called Evans Mills is built around an existing pond. In 1994, the waterfront homes sold for an average $17,467 premium above the average price of homes not facing the pond (Wade, 1995).*

- *Franklin Farms, a single family home residential neighborhood in northern Virginia has a 5-acre urban runoff detention area surrounded by a walking path. Waterfront homes in this development sold for 10 to 20 % more initially and again at resale than land with no water view (Downham, 1995).*



2.7 Non-Stormwater Discharges

The seventh tool, non-stormwater discharges, involves choices on how to control discharges from wastewater disposal systems, illicit connections to stormwater systems, discharges from failing septic systems, and reducing pollution from household and industrial products. The EPA estimated the annual benefits of current water quality levels relative to what they would have been without water pollution control programs, particularly the Clean Water Act. This benefit was estimated to be $11 billion annually (USEPA, 2000).

One type of non-stormwater discharge is septic system effluent. In areas outside water and sewer service areas, septic systems are used to treat wastewater. In order to be effective, septic systems must have appropriate drainage area and soils as well as be maintained regularly. There are costs associated with failing septic systems. A failed or failing septic system can decrease property values, delay the issuance of building permits, or hold up the purchase settlement (NSFC, 1995). In the event a septic system fails, homeowners can expect to pay from $3,000 to $10,000 for replacement (Schueler, 1997).

2.8 Watershed Stewardship

The final tool, watershed stewardship programs, involves careful choices about how to promote private and public stewardship to sustain watershed management. Many communities now invest in programs of watershed education, public participation, watershed management, monitoring, inspection of treatment systems, low input lawn care, household hazardous waste collection, or industrial and commercial pollution prevention programs. The common theme running through each program is education, and although this is somewhat difficult to put a price on, some examples are listed below.

- The Chesapeake Bay Restoration fund reports revenues of $341,811 in the year 2000 from donations, while sales of bay plates have climbed to $1 million per year.

- The Mattaponi and Pamunkey Rivers Association in Virginia reports they receive over 3,000 volunteer hours annually for water quality monitoring, trash cleanup, and community education. Assuming public works employees were paid $15/hour for the same work, this results in a savings of over $45,000 per year just from one organization's efforts. There are currently over 300 watershed organizations in the Chesapeake Bay watershed alone.

- The Alliance for the Chesapeake Bay reports they currently have 145 volunteers who perform weekly water quality monitoring, which allows the paid staff to address other critical issues.

- The Chesapeake Bay Foundation reports an estimated 300,000 volunteer hours per year bay-wide for projects such as bay restoration and cleanup. They estimate this benefit to be worth $3 million annually based on a rate of $10 per hour of work.

- Education about lawn care practices has an associated cost reduction. In 1981 the city of Plano, Texas, instituted a program that encouraged residents to leave clippings on home lawns to provide nutrients and moisture. Knopp and Whitney (1989) reported that the city saved $60,000 in disposal costs the first year, even though the number of households served increased 12% over the same period. Residents participating in the program saved $22,000 in leaf/lawn bag purchases (Knopp and Whitney, 1989).

- In Seattle, an education program encouraged urban citizens to compost yard and food wastes. About 5,300 tons of yard waste were removed from disposal annually, for a net savings of $378,000 (EPA, 1991).

- Raup and Smith (1986) reported that integrated pest management (IPM) reduced community pest management costs by 22%, even though more pests were controlled under the new program. The use of expensive chemicals to control weeds can also be substantially reduced.

- Conserving native vegetation results in significant costs savings for maintenance. Americans spend over $7.5 billion each year on lawn care products to maintain turf lawns (CWP, 1998). Native vegetation is usually low-maintenance and is better adapted to climatic changes and pests, therefore does not require the use of fertilizer or constant watering that is characteristic of the turf lawn (CWP, 1998).

3.0 Conclusions

Environmental regulations cost money to implement. However, the related benefits and savings can be equal to or greater than the costs. This report documents the economic benefits of specific environmental regulations including: floodplain, water quality, conservation area protection, buffers, erosion and sediment control, and zoning regulations. The numerous sources of references in this report identify several types of economic benefits resulting from these regulations. These benefits include increased property values, income from fisheries, recreation, tourism, and the marine industry, as well as savings or avoidance of costs related to flood damage, stormwater treatment, construction, infrastructure and maintenance, drinking water treatment, home heating and cooling, medical treatment, and stream/lake restoration. These economic benefits, combined with the other, immeasurable benefits of preserving forests, and protecting habitat, biodiversity and natural resources, makes the decision to establish environmental regulations a justifiable and responsible approach to protecting water resources and the environment in general.

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